E. J. BUTLER.

SCOTTISH SOCIETY FOR RESEARCH

IN PLANT-BREEDING

REPORT

BY THE

DIRECTOR OF RESEARCH

TO THE

ANNUAL GENERAL MEETING

26th July 1934

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1934

SCOTTISH SOCIETY FOR RESEARCH IN PLANT-BREEDING.

REPORT

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DIRECTOR OF RESEARCH.

I. Research Programme.

The aim of the Society is to promote research for the improvement of plants and crops in Scotland. The crop plants on which breeding experiments are being carried out are chiefly Oats, Potatoes, Herbage (Perennial Ryegrass, Cocksfoot, Timothy and Plantain) and Swedes.

A. Cereals.

Oats.

In continuation of the cereal-breeding, a large collection consisting of both unfixed and fixed hybrid plants was grown for observation. The drought in 1933 shortened the growing season, and in consequence of the rapid ripening of the plants decisive comparisons were more difficult to make.

An endeavour is being made to procure improved early ripening varieties. Many selections of this type were grown, and they were compared as to their relative degrees of utility, the yield of grain, strength of straw, and period of maturity being some of the important characters that were noted. In testing very early ripening varieties at the Station, reliable comparisons of yield have frequently been difficult to make on account of birds devouring much of the grain before the plants were ripe. An attempt to overcome this hindrance was

made last year by sowing the earliest-ripening varieties about fourteen days later than those which have a distinctly longer growing period. Those that were later sown grew quite well, ripened about the same time as the earlier-sown varieties, and suffered little damage by the depredations of birds. Early ripening selections have been retained for further trials from the offspring of Orion × Sandy, Castleton Potato × Yielder, Elder (type) × early ripening unnamed hybrid selection, and from two unnamed hybrid selections. Some of these early ripening sorts produce an attractive sample of grain, but the straw is perhaps rather weak, at least when grown at Corstorphine. This weakness might not be so apparent, however, if they were grown on less fertile soils, for which it is hoped some of them may be well adapted.

The experimental breeding work has indicated that a good yield of grain can be associated with a relatively short type of straw which is resistant to lodging. The search for new varieties with a good quality of upstanding straw has been continued, and many hybrid progenies have been carefully examined for plants of the desired type. A very promising collection of hybrids has been selected from the offspring of Victory × Potato, Castleton Potato × Yielder, and Potato × Record. In all of these, when plants for propagation were being selected, preference was given to those possessing medium-sized, well-filled grain, a type which is frequently preferred by millers and others. Oats for milling should be well-filled and thin-skinned. Some of the highest grain-yielding varieties presently on the market have large grain which shows a higher proportion of husk and fibre than that of some of the lower-yielding varieties which are highly favoured as milling oats, and a practical plant-breeding problem is to find out how far in one variety the best milling-quality grain can be associated with a capacity for high grain yield.

Twenty-one fixed but unnamed varieties were compared with nine named varieties in yield trial plots at the Plant-Breeding Station in 1933. As already mentioned the drought in the summer hastened the ripening of the plants, and as a result the grain was not so well filled as that of the 1932 crop. Generally the short-straw varieties suffered more than the longer-straw ones from the lack of moisture. The general average of the yield of grain was just about 76 per cent of that

obtained in 1932. No significant differences in yield of grain were shown between the varieties, Early Miller, Marvellous, Record, Victory and Yielder. In comparing the yields statistically, differences of more than three times the standard error—a statistic calculated from figures obtained from the trials—were regarded as indicating a significant difference. The estimated yield of grain per acre from the standard variety, Victory, was about 77 bushels, whereas from the previous year's crop the yield of this variety was estimated at 91 bushels per acre. In that year also there was no significant difference in grain yield between Early Miller and Victory.

Early Miller.—This variety was included in the Registration Trials carried out by the Department of Agriculture for Scotland, and also in various other trials conducted by the Agricultural Colleges in Scotland. The results of the tests in many different areas were highly satisfactory, and the variety was registered by the Department of Agriculture for Scotland in January 1934 in terms of their Scheme for the Registration of Cereals. The official description of it, as given in the Certificate of Registration, is as follows :—

> "A white-grained oat which is in general character intermediate between its parents, Potato and Record ; an early ripening variety suitable for early cultivation and high yielding on fertile soils. The grain is short and plump, well-filled and of an attractive colour ; not thick in the husk, gives a high bushel weight, and shows promise of being a high-class milling oat. The straw is of good fodder quality and of medium length and possesses a high degree of resistance to lodging."

In the 1933 Registration Trials, Early Miller gave a yield of dressed grain of over 30 cwt. per acre, and it was the first variety in the trials to reach maturity. Despite the very dry season high yields of grain were also reported from various other trials in different areas in Scotland, the heaviest yield being at the rate per acre of about 46 cwt. of total grain in the trial in Kincardineshire. In East Aberdeenshire on good haugh land Early Miller gave a yield of 28 cwt. of dressed grain per acre, the highest yield obtained in the trial, which included Marvellous, Star, Yielder and Castleton Potato.

The quality of Early Miller grain has been very favourably reported on by the managing directors of two well-known firms of oat-meal millers. One report, made before the variety was named, states—

> "I have had an opportunity of examining the sample of the unnamed New Variety of Oats which you gave me. The oats are thin-skinned, well-filled and appear to be of a heavy natural bushel weight. So far as one can estimate, I consider the Oats would yield about 56 per cent of high dried Oatmeal. The average yield of all oats is lower this season than the 1932 crop. From a milling point of view the Oats are very promising, as they do not appear to be so fibrous as many varieties grown at present, which make Oatmeal of a poorer quality than the old Potato and other thin-skinned varieties."

The other report states—

> "We consider this a most excellent type of milling-quality oat, and would be only too pleased if we could obtain regular supplies of oats of this description. Unfortunately there is a tendency now amongst farmers to grow very coarse-skinned oats which are most unsuitable for milling."

The results of the chemical analyses, which were kindly undertaken by Dr Alex. Lauder, Edinburgh and East of Scotland College of Agriculture, Edinburgh, of the grain of four varieties—viz., Early Miller, Potato, Record and Yielder, are shown in Table I. On the whole the analyses do not show much difference in the composition of the grain of these varieties, but as the grain of the Potato variety is usually regarded as representing a high standard of feeding-quality oats, it is worthy of note that the Early Miller grain shows a content of 5.40 per cent of oil as compared with 4.04 per cent shown by the grain of Potato.

TABLE I.

ANALYSES OF SAMPLES OF THE GRAIN OF FOUR VARIETIES OF OATS GROWN AT THE SCOTTISH PLANT-BREEDING STATION IN 1933.

VARIETY.	EARLY MILLER.	POTATO.	RECORD.	YIELDER.
Crude Protein (Albuminoids)	9.68	10.87	9.86	8.84
Oil (Ether Extract) . .	5.40	4.04	3.52	3.04
Crude Fibre . . .	10.92	9.34	11.04	14.36
Soluble Carbohydrates .	62.90	62.48	62.80	59.92
Mineral Matter . .	2.59	2.59	2.66	2.84
Moisture . . .	8.51	10.68	10.12	11.00
	100.00	100.00	100.00	100.00
Weight of 1000 grains in grams . . .	38.12	30.67	37.82	42.67

About 15 tons of seed of Early Miller oats were available for distribution amongst members of the Society, and there was a very keen demand for this seed. In view of the fact that applications for relatively large amounts had been received, it was decided that no applicant should receive more than 15 cwt. After the usual germination tests had been made, the seed was allocated and despatched to applicants.

Favourable reports continue to be received regarding the Elder and Bell oats, two varieties raised at the Scottish Plant-Breeding Station. It will be of interest to members to quote one of these reports on the 1933 crop, made by a farmer and sent to the Plant-Breeding Station by a member of the Society in the West of Scotland—

> "The Elder oat did extra well this year. The best oat I have had on my farm. About a week later than . . . but stood up where . . . went down. They were both sown at the same time and were both Ceresan dressed. The feature of the Elder oat was the great head of corn."

Barley.

A collection of named varieties was grown as in previous years, and it included a few interesting forms received from the Institute of Plant Industry, Leningrad.

The selections received in 1932 from Mr Thomas Anderson, Corstorphine, were still further reduced in number by the elimination of those which showed serious lodging or other faults. Five selections only were retained for trial in 1934.

Wheat.

About the usual number of named varieties of wheat were grown in small plots.

Some of the hybrid selections which Mr J. M. S. Lang, Temporary Junior Assistant, has been studying have now reached the sixth generation, and it is hoped that some useful strains will be obtained from them. These comprise crosses between *Triticum spelta* and some of the common named varieties of *T. vulgare*, and they were made with a view to introducing into the cultivated type some of the winter-hardiness of the spelt variety. Many diverse types have appeared as a result of the cross, and it seems that the desired types will be difficult to fix. Several of the selections, however, which showed distinct promise in 1933 have been continued in 1934.

Another series of hybrids from which practical results may be obtained consists of crosses between winter wheats and spring wheats. These were made with a view to obtaining some improved spring-sown sorts, and some strains have now been evolved which appear to be promising.

B. Potatoes.

Assistant in Charge—William Black, B.Sc., Ph.D. (Ainville Sub-Station).

The investigations are chiefly concerned with the production of new varieties of commercial value, and with the collection of data which will lead to the principles which govern the

transmission of characters of economic importance being better understood. The possibility of introducing new characters from wild species is receiving attention.

First-year Seedlings.—Over 2500 new seedlings were raised during 1933 at the Sub-Station, Kirknewton. Fully half of them were obtained by hybridisation of varieties chosen in most cases on account of their early maturity. The undernoted crosses gave a high proportion of promising seedlings, and in many the essential economic characters were of a high standard.

Di Vernon	× 188a(91);	Arran Rose	× Majestic;
Epicure	× 188a(91);	British Queen	× 135(10);
Immune Ashleaf	× 188a(91);	Up-to-Date	× 135(10);
	Puritan × 188a(91).		

The parent variety 188a(91) gives promise of being a very useful type for breeding; it is an immune 2nd-early which flowers profusely and provides an abundance of viable pollen. Its parents are Majestic and a Great Scot seedling.

The progeny derived from Di Vernon × 188a(91) was characterised by containing a large number of plants with parti-coloured tubers. Many were like the variety King Edward VII., but bluish-purple as well as reddish-purple types were obtained, and the coloured-surface area ranged from wholly pigmented to white. Among the first-year seedlings there was one progeny derived from wart-susceptible varieties —viz., May Queen × Sharpe's Victor, and it comprised 27 susceptible and 2 immune plants. This proportion of susceptible plants indicates the disadvantages of crossing two susceptible varieties. The use of one susceptible parent when desired is not a serious drawback since, on the average, about 50 per cent of the seedlings are resistant.

In connection with the investigations on the effect of repeated self-fertilisation of potato varieties, over 900 plants were raised. The majority of the lines have now reached the sixth inbred generation, and all show a definite advance towards uniformity. Several appear to be breeding true for particular characters, but all are still heterozygous in some respect. One particular line has reached an advanced stage of degeneracy —due presumably to unsuitable combinations of factors—and the plants are malformed dwarfs giving practically no tubers.

Over 300 seedlings derived from wild solanum species and species hybrids were also grown. While these plants have no immediate economic value, some of the wild solanums possess desirable characters such as resistance to blight, and it would be advantageous to introduce them in a commercial variety. It is intended to continue these experiments with that object in view.

Investigations on wart disease resistance have been made in the past few years, and the results obtained have been interpreted and arranged in the form of a paper entitled " Studies on the inheritance of resistance to wart disease (*Synchytrium endobioticum* (Schilb) Perc.) in potatoes." This paper has been accepted for publication in the ' Journal of Genetics.'

Second-year Seedlings.—Over 500 seedlings were grown in small pots, and many promising selections made. These will be compared in larger plots in 1934. Some of the most promising seedlings in this group were derived from the new seedling 135(10) which has been widely used as a male parent. This variety, although not free-flowering, produces abundant viable pollen, and there are indications of its being a valuable parent.

Third-year Seedlings.—About 170 seedlings were grown in trial and multiplication plots and their characteristics compared with standard varieties. Samples of the majority of them were also grown at other centres—*e.g.*, Craigs House, East Craigs, Philipstoun, Huntly and Ormskirk.

Trials.—Trials of about 250 second-year, third-year and older seedlings were carried out at the Plant-Breeding Station, Corstorphine.

A number of samples were grown in the Preliminary Trials carried out by the Ministry of Agriculture and Fisheries at Ormskirk. In the Wart-Disease Immunity Trials at Ormskirk, three varieties were included in the first-year and two in the second-year test.

In the Registration Trials carried out by the Department of Agriculture for Scotland there were 12 of the Society's varieties, 1 in the third-year's trials, 3 in the second and 8 in the first. Four of these seedlings have been recommended for further trial—viz., 135(10), 151(80), 967c(38) and D9(9). A brief description of these is given in Table II. Seedling 135(10) is a very promising variety and will undergo its final test in 1934. From the 1933 crop, which was grown at Ainville

Sub-Station and was free from symptoms of virus disease, about 16 cwt. of tubers (ware and seed size) were available for seed.

151(80) is a heavy yielding 1st-early which bulks at an early stage and possesses a haulm more frequently associated with types of later maturity. In the trials it out-yielded Epicure both in total yield and in yield of ware.

967c(38) is a maincrop whose haulm shows a high degree of blight resistance. Its foliage is very abundant and of a lighter shade of green than the average.

D9(9) is a promising variety of the Up-to-Date type. It has a strong haulm with abundant foliage and an attractive habit of growth.

As a result of the various trials in 1933, six seedlings have been selected for inclusion in the Registration Trials carried out by the Department of Agriculture for Scotland (see Table) and five in the Wart-Disease Immunity Trials of the Ministry of Agriculture and Fisheries.

[TABLE II.

TABLE II.

NOTES WITH REFERENCE TO PARENTAGE, ETC., OF TEN PROMISING UNNAMED SEEDLINGS.

Reference Number.	Parentage.	Maturity.	Tuber.		Cooking Quality.
			Shape.	Colour.	
135(10) . .	Abundance × Majestic	2nd-Early	Oval	White	Very good
151(80) . .	Kerr's Pink × 966b(4)	1st-Early	Round	Pink	,,
967c(38) .	Bishop × 800(2)	Maincrop	Oval	White	,,
D9(9) . .	Up-to-Date × Majestic	Maincrop	Oval	White	Good
189a(73) .	Majestic × 121(4)	2nd-Early	Oval	White	,,
212a(22) .	Epicure × 135(10)	1st-Early	Oval	White	Very good
212a(82) .	Epicure × 135(10)	1st-Early	Oval	White	,,
212a(111) .	Epicure × 135(10)	1st-Early	Oval-Kidney	White	,,
212b(59) .	Epicure × 135(10)	1st-Early	Oval-Kidney	White	Good
246(37) .	Majestic × 135(10)	1st-Early	Oval-Kidney	White	,,

C. Herbage Plants.

Assistant in Charge—J. W. Gregor, Ph.D., F.L.S.

The investigations relating to the improvement of herbage plants were continued. These have involved intensive breeding work with timothy, cocksfoot and perennial ryegrass. Last season four new strains of grasses were further multiplied. These consist of two of pasture (diploid) timothy, one of a soft-leaved cocksfoot and one pasture strain of perennial ryegrass. In previous reports the fact that a species, *e.g.*, timothy, possesses races which require different environmental conditions for their optimum development has been stressed, because these different requirements indicate possibilities of developing strains suited to the diverse environments encountered in agricultural practice. To achieve this object investigations in dissimilar regions necessitating the co-operative efforts of workers situated in different parts of the country are required. At the present time no facilities are available at Craigs House for carrying out variety grazing trials, but by arrangements with the Agricultural Colleges several observational grazing trials were laid down in the spring of 1933 in various parts of Scotland. From these trials, each of which is approximately one acre in extent, it is hoped to obtain profitable information. The system as at present in operation, however, cannot be expected to yield data of as critical a nature as is desired, because the method employed for the estimation of the value of strains is the arbitrary one of eye inspection. Nevertheless, although no conclusive information regarding the nature of conditions most suitable to optimum development can be obtained, yet the observations should give some indication of the agricultural conditions which favour the strains in question.

The investigations dealing with general problems of crop improvement have also been continued, and are regarded as an important part of the Society's research programme. These investigations are planned to contribute information concerning technical problems relating to seed-growing methods, the maintenance of cross-fertilising strains at a desired level of purity, the detection of changes in the composition of strains, &c. For instance, the study of environmental races of timothy and sea plantain which has been in progress for the past few years is supplying information regarding the influence of the

environment on the heredity of plants composing a freely crossing population, an inquiry which has an important bearing on the problem of agricultural utilisation and maintenance of strains.

In the light of recent investigations measures for the agricultural utilisation of the plant breeder's products have been reviewed from the technical standpoint in an article entitled, "The ecotype concept in relation to the registration of crop plants" (Ann. Appl. Biol., Vol. XX., No. 2, 1933). The conclusions arrived at have reference primarily to the methods of dealing with new strains previous to their introduction into agricultural practice, and thus have an indirect bearing on practical issues. Briefly, these conclusions suggested the need for the following: (1) the classification of crop units according to their environmental preferences (two units have been proposed and discussed, (*a*) the *agrotype* or ultimate crop unit, and (*b*) the *agro-ecotype* or group of agrotypes possessing similar environmental preferences); (2) the charting of agricultural environmental regions; (3) the organisation of a crop registration and variety information bureau (Central Institute) to which the farmers and agricultural county organisers could apply for information; (4) the co-operation of workers in regional areas for the purpose of determining the behaviour, under local conditions, of varieties submitted to them by the Central Institute; and (5) the co-ordination at the Central Institute of the results obtained by all concerned. The main part to be played by crop research institutes in such a co-operative effort of crop improvement would be the production of new varieties and the study of technical problems, both of which are essential to further progress.

A considerable amount of the recording and the statistical work involved in the investigations outlined above was undertaken by Mr J. M. S. Lang, Temporary Assistant and Recorder.

D. Root Crops.

(*Swedes and Turnips.*)

Assistant in Charge—V. E. M'M. Davey, B.Sc., Ph.D.

The primary purpose of the experiments with swedes is the examination of various methods for the selection and com-

parison of individual plants intended for use in breeding, with a view to obtaining improved strains or varieties.

Pedigree Breeding.—About 200 strains of swede were sown in various groupings, with certain commercial varieties as controls. Most of the strains were arranged in duplicate as small and large observation plots, while some were sown in the form of replicated yield trials. The pedigree strains under examination were mainly bronze and green-tops, some of which were in the sixth generation from selections originally made in 1921. A large number of unfixed strains from inter-varietal crosses were arranged for tests of yield and dry-matter content. Observations were made periodically during the season on all plots, and in the autumn representative selections were made for propagation. The 'Roots' Sub-Committee inspected the trials in October, when it was decided that the work of selecting and breeding swedes resistant to finger-and-toe disease should be undertaken on a more extended scale, and that further observations should be made as regards the occurrence of mildew on swedes.

Diseases.—The work on finger-and-toe disease in 1933 consisted of examining the progenies of thirteen resistant turnips of the Bruce type, with some other turnips as controls, in the specially infected plot. The field-trial plots suffered from this disease more than they have done since 1927, so that observations on disease resistance could also be made thereon. A line of swedes, which in former years had shown relative resistance to finger-and-toe disease, was multiplied up with a view to having larger trials in infected fields. Mildew occurred throughout the trials, being favoured apparently by the dry summer. Some lines showed the infection earlier and more abundantly than the majority, while other lines were seen to develop healthy young leaves more vigorously after the return of wet weather conditions.

Controlled Seeding.—About 180 strains of swede were harvested. These included 10 new hand crossings, 3 strains mass-multiplied under natural isolation, and the remainder self-fertilisations under bag isolation. Some 75 of these strains were pedigree lines selfed for periods ranging from two to five generations; 12 were new selections from commercial stocks; and the rest were products of hybridisations selected for one or several generations.

Analysis of Hereditary Characters.—Further investigations

were made on the manner of inheritance of various characters, such as yield, dry-matter percentage, shape of bulb, colour of flesh and skin, shape of leaf, splitting and bolting.

' Bulbless Bolters ' and Rape.—Dr J. W. Hadfield, of the New Zealand Department of Agriculture, has grouped the swede-like rapes of commerce into three groups, which are described in the New Zealand Journal of Agriculture, Vol. XLIII., No. 4, October 1931. Samples of his types were grown at the Station for comparison with progenies of a number of bulbless rogues obtained from various commercial crops of swedes. These bulbless strains could be classed with two of the rape types—viz., Type I., which has swede-like, curving leaves ; and Type II., in which the leaves are erect and rigid and there is little susceptibility to bolting. It was also observed that the flower colour of Type I. was bright lemon-yellow, while that of Type II. was a paler and duller yellow, but both were distinct from the buff colour of the yellow-flesh swede.

Yield Trials.—There were available about 75 unfixed strains of swede derived from crossings between varieties. In some cases the bulb of the immediate parent had been selected for dry-matter and weight, and it was desirable to make a preliminary test of the worth of all the strains. Yield trials were employed for as many as possible, while single-plot determinations of yield and dry-matter were carried out on the rest. Fifty-three of the strains were descended from a cross between a Green-Top Globe × Purple-Top Tankard. Besides the three small yield trials laid out for these, a fourth was employed to test mass-multiplied strains, wherein the dry-matter content of Ds 21 was as good as, but not definitely better than, a similar bronze-top globe variety. There were also two small trials for pedigree lines, continuing some investigations into hereditary variations.

Other Analysis.—Numerous single-bulb tests for weight and dry-matter content were made, including about 140 large bulbs of a segregating population which were stored in a pit until the end of the analytical season.

E. Virus Disease Research.

E. C. Barton-Wright, M.Sc., F.R.S.E., *Chief Assistant, Craigs House.*
George Cockerham, B.Sc., *Assistant, Huntly Sub-Station.*
Alan M. M'Bain, B.Sc., *Assistant, Ainville Sub-Station.*

During the year 1933-34 both genetical and physiological investigations were carried out on the potato virus problem at the Corstorphine Station and Ainville Sub-Station.

On the genetical side the breeding work has been confined to attempting to find a possible resistant variety to leaf-roll. Field tests were carried out with a large number of varieties in order to determine whether or not any resistance to leaf-roll could be discovered in present-day commercial types. Of the various varieties tested, four (Shamrock, Cardinal, Chance and Kepplestone Kidney) showed marked resistance. The season of 1933 was excellent for the spread of leaf-roll, and with the exception of the four varieties enumerated above, all the tested plants became infected. From previous grafting tests it had been found that Shamrock shows leaf-roll only to a small extent and appears to be the most resistant variety we have at present to this disease. Since this variety possesses viable pollen, a number of crosses have been effected with susceptible types. The seed from these crosses has now been sown and has shown good germination. It is hoped that the results will indicate whether any segregation takes place and whether it is possible to breed a resistant variety to this disease. A number of natural-selfs of Shamrock were also obtained, and these have now been sown. Tubers from a natural self of Shamrock grown last season have been obtained from the Huntly Sub-Station, and these will be tested this year for resistance to leaf-roll. A berry obtained from Arran Victory (comparatively resistant) × Pepo (susceptible) in 1932 had particularly good seed which produced robust seedlings. These seedlings are now being subjected at Corstorphine to the usual tests for resistance to leaf-roll. In a number of them the tubers are very shapely and of a desirable colour.

On the physiological side, observations on the nitrogen metabolism of healthy and crinkle-infected potatoes have been completed, and the results will shortly be published. It had

been found in a previous year that crinkle did not affect the carbohydrate metabolism to any significant extent, and in the circumstances it became necessary to seek the cause of loss of yield elsewhere. It has now been found that the nitrogen metabolism in diseased plants is seriously disturbed in a variety of ways. The total nitrogen in leaves, petioles and stems of diseased plants is significantly higher than in healthy material, and further, the upward transport of nitrate nitrogen and the downward translocation of elaborated organic nitrogen is interrupted.

Huntly Sub-Station.—Progress has been made during the year in the continued study of hereditary and virus-induced degeneracy in potato progenies. The outstanding problems have been examined on more quantitative lines than hitherto, and particular attention has been directed towards the production of 'seedling leaf-roll' in progenies derived from parents carrying individual viruses and virus complexes. The number of plants of the seedling leaf-roll type appearing in such progenies has been shown to be correlated with the severity of virus infection of the parents and to be independent of the virus concerned. Degeneracy of this type in individual seedlings amongst progenies of virus-infected parents is considered to be induced by reason of metabolic disturbances in the latter.

Pollen sterility of varying degrees has been found to be concomitant with a decrease in flowering capacity, malformation of floral parts and a tendency for flowers to fall in plants affected with virus diseases. These factors are responsible for the greatly reduced number of berries and the smaller number of seeds per berry amongst virus-infected plants than amongst corresponding healthy plants.

Several seedling progenies of selected parentage have been raised for the purpose of examining the possible genetical relationships of susceptibility and resistance to virus diseases. The speed of this investigation is limited by the lack of field space and the length of time required to make satisfactory field tests for infection. On this account laboratory methods of testing tubers for infection, and also for relative susceptibility and resistance, are claiming attention.

An extensive investigation into the metabolic activities with regard to carbohydrates and nitrogen has revealed considerable differences between normal and mosaic-infected potato plants.

particularly in respect of nitrogen metabolism. The data obtained are undergoing statistical analysis in preparation for publication.

Collaboration with the work in progress at Craigs House and Ainville has been maintained throughout the year, particularly with regard to the production and maintenance of healthy material.

II. Publications, Lectures and Official Visits by Staff, for the Year ended 31st March 1934.

PUBLICATIONS (P) AND LECTURES (L).

Director of Research :—

" Inheritance in Oats, with special reference to Striped Leaves." World's Grain Exhibition and Conference, Regina, Canada, July 1933. (L)

" Oat Varieties." Biggar Agricultural Discussion Society, 28th November 1933; and Loch Lomond and District Agricultural Discussion Society, 8th February 1934. (L)

J. W. Gregor, Ph.D., F.L.S. :—

" The Ecotype Concept in relation to the Registration of Crop Plants." Ann. Appl. Biol., Vol. XX., No. 2, 1933. (P)

" Growth Form in relation to Herbage Plants." Agricultural Education Association, Cambridge, 19th July 1933. (L)

William Black, B.Sc., Ph.D. :—

" Studies on the Inheritance of Tuber Colour in Potatoes." Journal of Genetics, Vol. XXVII., No. 2, 1933. (P)

V. E. M'M. Davey, B.Sc., Ph.D. :—

" Some Inter-Relationships of Plant Species." Dunfermline Natural History Society, 12th December 1933. (L)

E. C. Barton-Wright, M.Sc., F.R.S.E. :—

"First Sugar of Photosynthesis." Glasgow Botanical Society, 5th December 1933. (L)

E. C. Barton-Wright, M.Sc., F.R.S.E., and Alan M. M'Bain, B.Sc. :—

"Studies in the Physiology of the Virus Diseases of the Potato. II. A comparison of the carbohydrate metabolism of normal with that of crinkle potatoes; together with some observations on carbohydrate metabolism in a 'carrier' variety." Ann. Appl. Biol., Vol. XX., No. 4, November 1933. (P)

"Studies in the Physiology of the Virus Diseases of the Potato. III. A comparison of the nitrogen metabolism of normal with that of leaf-roll potatoes." Ann. Appl. Biol., Vol. XX., No. 4, November 1933. (P)

"Possible Chemical Nature of Tobacco Mosaic Virus." A Letter to the Editor, 'Nature,' Vol. CXXXII., No. 3348, 30th December 1933. (P)

George Cockerham, B.Sc. :—

"Potato Virus Diseases." Agricultural Discussion Society, Milfield, 10th January 1934; and Agricultural Discussion Society, Ancroft, 11th January 1934. (L)

Alan M. M'Bain, B.Sc. :—

"Nitrogen Metabolism of Healthy and Leaf-Roll Potatoes." Society of Experimental Biologists, Leeds, 8th July 1933. (L)

Visits.

Director of Research :—

The World's Grain Exhibition and Conference, Regina, Canada, 21st July to 5th August 1933.
Dominion Experiment Farm, Ottawa, Canada.
Agricultural College, Guelph, Ontario, Canada.

The Dominion Experimental Farm, Indian Head, Sask., Canada.
Agricultural Department, University of Manitoba, Winnipeg, Canada.
Agricultural Department, Macdonald College, St Anne's, Quebec, Canada.
Agricultural Department, Cornell University, Ithaca, U.S.A.
Boyce Thompson Institute for Plant Research, Yonkers, New York, U.S.A.

After my appointment by the Department of Agriculture for Scotland as Scottish Delegate to the World's Grain Exhibition and Conference, I was granted permission by the Directors of the Society to proceed on leave on 28th June so that I might have time to visit several of the Experimental Stations in Canada and the U.S.A. before attending the Grain Exhibition and Conference at Regina. Only a very brief statement regarding the Exhibition and Conference is possible here.

Grain Exhibition.—There were three classes for oats, and the exhibits from Great Britain and Ireland included 22 from Scotland, 4 from England and 2 from Northern Ireland. There were only a few samples of wheat and barley from Scotland. It was officially stated that "the Exhibition is primarily a seed exhibition rather than an exhibition purely of commercial grain, and that in placing awards consideration will be given to several characteristics which together make for good seed and good grain." These characteristics fell into two main groups —viz., purity of variety and of sample, and general quality and soundness of the sample. All the prize-winning samples of grain had been very carefully graded, clipped and polished. The British samples of grain were well dressed, but in general they lacked the high degree of uniformity, and some were not so attractive in colour as were the leading Canadian and American exhibits. Only two of the oat exhibits from Scotland were awarded prizes. These prizes were the 25th and the 33rd in a group of 23 entries (two of which were from Scotland) in the yellow-grained class. In this class prizes 11 to 24 inclusive were not awarded. In the class for medium or late-ripening oats there were 81 entries, 11 being from Scotland, 3 from England and 1 from Northern Ireland. In the class for early ripening varieties there were 78 entries, including

9 from Scotland, 1 from England and 1 from Northern Ireland. Competition in the last two classes was very keen, and many of the prizes went to the Alberta and Saskatchewan regions of Canada. Two prizes, 26th and 27th, for barley (two-rowed Duckbill or Thorpe type) came to Scotland. There were 36 entries in this class. The highest award which came to the European side of the Atlantic was 1st prize for flax seed fibre, and this was gained by the Ministry of Agriculture, Northern Ireland.

The Grain Conference.—The papers read at the Conference covered a very wide range, and they showed that a vast amount of work is being carried out at the Canadian Agricultural Experiment Stations to procure practical results through the application of scientific principles. A very encouraging measure of success has already attended these efforts: rust-resistant varieties of wheat; early maturing varieties of oats, barley and wheat; improved varieties of maize, alfalfa and soy beans having been produced.

I desire to record my thanks for the kindness and courtesy with which I was received at the World's Grain Exhibition and Conference, and also at the various institutions which I had the pleasure of visiting during my trip to Canada and the United States of America.

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Ormskirk Potato Trials, Ormskirk, Lancashire.

III. Demonstrations.

Several agricultural parties and a number of research workers visited the Station at Corstorphine and the Sub-Station at Huntly, Aberdeenshire, at different periods throughout the year. The visitors were conducted round the experimental plots, and various aspects of the work at the Stations were described by members of the staff.

IV. Acknowledgments.

Grateful acknowledgment is made to the undernoted departments, institutes, firms and individuals for gifts of samples or other material for experiment :—

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Wenholz, Dr H., Department of Agriculture, Sydney, New South Wales, Australia.
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Thanks are also due to members of the staffs of the three Scottish Agricultural Colleges who arranged and supervised the trials of certain of the Society's new varieties of oats, and to Dr Alexander Lauder, Edinburgh and East of Scotland College of Agriculture, Edinburgh, for making chemical analyses of samples of oats.

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